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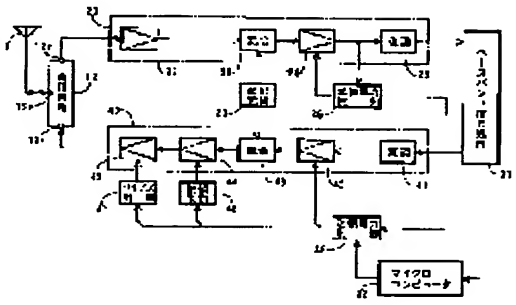
(54) RADIO TRANSMITTER AND CONTROL METHOD THEREFOR

(57)Abstract:
PROBLEM TO BE SOLVED: To compensate gain fluctuation of a high frequency power amplifier circuit in the case of switching transmission power in the radio transmitter of a transmission power control type.
SOLUTION: A prescribed high frequency signal is supplied from a variable gain drive amplifier circuit 44. An operating state of a plurality of field-effect transistors (TRs) of a high frequency power amplifier circuit 45 is selected for each group by a bias control circuit 47 controlled by a transmission power control circuit 46 to select transmission power. The transmitter is provided with a compensation control circuit 48 including a generating means for compensation information to compensate a gain fluctuation of the high frequency power amplifier circuit in this switching and the compensation control circuit controls the gain of the drive amplifier circuit under the control of the transmission power control circuit 46.



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CLAIMS

[Claim(s)]
[Claim 1] The RF power amplification means containing two or more active elements classified into two or more groups, and an information generating means to generate the transmitted power control information corresponding to the predetermined transmitted power of this RF power amplification means, The group control means which switches the operating state of the above-mentioned active element of the above-mentioned RF power amplification means for every above-mentioned group based on the above-mentioned transmitted power control information from this information generating means, It is the wireless sending set which equips the above-mentioned RF power amplification means with the adjustable gain magnification means for supplying a predetermined RF signal. A generation means of compensation information to compensate gain fluctuation of the above-mentioned RF power amplification means at the time of switching the operating state of the above-mentioned active element for every above-mentioned group is included. The wireless sending set characterized by establishing the compensation control means which controls the gain of the above-mentioned adjustable gain magnification means based on the above-mentioned compensation information and the above-mentioned transmitted power control information.
[Claim 2] The wireless sending set according to claim 1 which is a drive magnification means by which the above-mentioned adjustable gain magnification means supplies a RF signal to the above-mentioned RF power amplification means directly.
[Claim 3] The wireless sending set according to claim 1 which is an intermediate frequency magnification means by which the above-mentioned adjustable gain magnification means supplies a RF signal to the above-mentioned RF power amplification means indirectly.
[Claim 4] Two or more active elements of a RF power amplification means by which a predetermined RF signal is supplied from an adjustable gain magnification means are classified into two or more groups. It is the control approach of the wireless sending set which switched the operating state of the above-mentioned active element of the above-mentioned RF power amplification means for every above-mentioned group based on the transmitted power control information corresponding to predetermined transmitted power. The compensation information which compensates gain fluctuation of the above-mentioned RF power amplification means at the time of switching the operating state of the above-mentioned active element for every above-mentioned group is generated. The control approach of the wireless sending set characterized by controlling the gain of the above-mentioned adjustable gain magnification means based on this compensation information and the above-mentioned transmitted power control information.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the suitable wireless sending set of a transmitted power control mold for a cellular phone etc., and its control approach.
[0002]
[Description of the Prior Art] In many radio communication equipments, such as the former, for example, a cellular phone etc., transmitted power control is performed for reduction of power consumption, interference reduction with an other station, etc. Based on the indication signal from distant offices, such as a received signal level or a base station, by changing the drive signal level of a high-frequency power amplifying circuit, it consists of such radio communication equipments in many cases so that transmitted power control may be performed.
[0003] Moreover, in order to raise the effectiveness of the RF power amplification circuit at the time of a low transmitting output, the technique which controls the direct current power supplied to this RF power amplification circuit from a power source according to transmitted power control information is indicated by JP,1-314431,A, JP,6-93631,B, etc.
[0004] Each reduces a drain current and he is trying to decrease the power consumption of a high-frequency power amplifying circuit in these transmitted power control systems changing the gate voltage of the field-effect transistor which constitutes a high-frequency power amplifying circuit, or by reducing a drain electrical potential difference at the time of a low transmitting output.
[0005]
[Problem(s) to be Solved by the Invention] However, since it was not the ideal linear characteristic, in the above transmitted power control systems, the gate voltage pair drain current characteristic of a field-effect transistor was restrained by the fall of gain, and degradation of a distorted property, also at the time of a low transmitting output, it could not not much reduce the drain current of a field-effect transistor, and there was a problem that power consumption of a RF power amplification circuit could not be decreased sharply.
[0006] in order to solve such a problem, these people have already proposed "the RF amplifying circuit, sending set, and receiving set" which can boil power consumption markedly and can reduce it at the time of low-power output in the patent application on April 27, Heisei 7 (reference number S95021542).
[0007] In a proposed high frequency amplifying circuit, two or more field-effect transistors of source ground connection are classified into two or more groups, and the high frequency signal from an input terminal is supplied to the gate of a field-effect transistor common to the gate of all field-effect transistors through two or more capacitors for DC blocking connected in common for every group.
[0008] Moreover, the necessary gate bias voltage from which a field-effect transistor will be in operating state or non-operating state is alternatively supplied to the gate of a field-effect transistor through a resistor according to the transmitted power directions information from a base station for every group.
[0009] And while all the drains of each group's field-effect transistor are connected in common

and a power source is supplied through a high-frequency choke coil, the RF signal of each drain of a field-effect transistor is drawn by the output terminal. In addition, it is not necessary to necessarily make equal the number of each group's field-effect transistors.
[0010] When transmitted output power is high, while all groups' field-effect transistor is made operating state by the above configurations, when sending-signal power is low, some groups' gate bias voltage is switched and it is made non-operating state by them in a proposed high frequency amplifying circuit.
[0011] As Curve Lp shows to drawing 3 , by this in a proposed RF amplifying circuit at the time of the low-power output of 15dBm or less of output power So that a moiety may be mostly made into operating state among field-effect transistors Gate bias voltage is switched suitably, as a whole, a drain current can be reduced to abbreviation 1/2, and the power consumption of a RF power amplification circuit can be decreased sharply, without being accompanied by the fall of gain, and degradation of a distorted property at the time of a low transmitting output.
[0012] However, in the above proposed high frequency amplifying circuits, as Curves Hp and Lp show to drawing 4 at the time of the change of output power by control of actuation of a field-effect transistor, or not operating, about 1.3dB gain fluctuation arises and the problem that the discontinuity of this gain affects the stability of a radio communication equipment or a wireless circuit arises.
[0013] In view of this point, the purpose of this invention is in the place which offers the wireless sending set with which gain fluctuation of a RF power amplification circuit can be compensated at the time of the change of output power, and its control approach.
[0014]
[Means for Solving the Problem] In order to solve said technical problem, the wireless sending set by this 1st invention The RF power amplification means containing two or more active elements classified into two or more groups, and an information generating means to generate the transmitted power control information corresponding to the predetermined transmitted power of this RF power amplification means, The group control means which switches the operating state of the active element of a RF power amplification means for every group based on the transmitted power control information from this information generating means, It is the wireless sending set which equips a RF power amplification means with the adjustable gain magnification means for supplying a predetermined RF signal. It is characterized by establishing the compensation control means which controls the gain of an adjustable gain magnification means based on compensation information and transmitted power control information including a generation means of compensation information to compensate gain fluctuation of the RF power amplification means at the time of switching the operating state of an active element for every group.
[0015] Moreover, the control approach of the wireless sending set by this 2nd invention Two or more active elements of a RF power amplification means by which a predetermined RF signal is supplied from an adjustable gain magnification means are classified into two or more groups. It is the control approach of the wireless sending set which switched the operating state of the active element of a RF power amplification means for every group based on the transmitted power control information corresponding to predetermined transmitted power. The compensation information which compensates gain fluctuation of the RF power amplification means at the time of switching the operating state of an active element for every group is generated, and it is characterized by controlling the gain of an adjustable gain magnification means based on this compensation information and transmitted power control information.
[0016]
[Embodiment of the Invention] Hereafter, the gestalt of operation of the wireless sending set by this invention and its control approach is explained, referring to drawing 1 and drawing 2 .
[0017] The configuration of the whole gestalt of operation of this invention is shown in drawing 1 , and the configuration of that important section is shown in drawing 2 .
[0018] In drawing 1 , since it corresponds to a frequency division Dupleix method, the antenna 11 for transmission and reception is connected to antenna port 12a of the antenna common circuit 12. This antenna common circuit 12 is equipped with transmitting-side port 12t and port 12r of a

receiving side, and the band-pass filter (illustration is omitted) of a predetermined property is connected, respectively between antenna port 12a and transmitting-side port 12t and between antenna port 12a and receiving-side port 12r.
[0019] The RF signal from receiving-side port 12r of the antenna common circuit 12 is supplied to a mixing circuit 22 through the low noise RF amplifying circuit 21 of a receiving circuit 20. The local oscillation signal from the local oscillation circuit 23 is supplied to this mixing circuit 22, and the RF signal from the low noise amplifying circuit 21 is supplied to the received-power detecting circuit 26 while it is changed into an intermediate frequency signal and supplied to a demodulator circuit 25 through the intermediate frequency amplifying circuit 24.
[0020] While negative feedback of the output of this received-power detecting circuit 26 is carried out to the intermediate frequency amplifying circuit 24 and that gain is controlled automatically, the output of a demodulator circuit 25 is supplied to the baseband signaling processing circuit 31, predetermined signal processing is performed, and receipt information, such as a sound signal, is reproduced. The transmitted power directions information from a base station etc. is included in the reproduced receipt information, and this directions information is incorporated by the microcomputer 32.
[0021] Moreover, in the baseband signaling processing circuit 31, predetermined signal processing is performed to transmit information, such as a sound signal, the output signal of the baseband signaling processing circuit 31 is supplied to the modulation circuit 41 of a sending circuit 40, and the output of a modulation circuit 41 is supplied to a mixing circuit 43 through the intermediate frequency amplifying circuit 42.
[0022] The local oscillation signal from the local oscillation circuit 23 is supplied to this mixing circuit 43, and the intermediate frequency signal from the intermediate frequency amplifying circuit 42 is changed into a RF signal, and is supplied to transmitting-side port 12t of the antenna common circuit 12 through the drive amplifying circuit 44 and the RF power amplification circuit 45.
[0023] In addition, as for the intermediate frequency amplifying circuit 42, the gain is controlled by the transmitted power control signal from the transmitted power control circuit 46. This transmitted power control signal is generated based on the received-power detection information from the received-power detecting circuit 26, and the transmitted power directions information from a microcomputer 32. The above configurations are the same as that of a proposed wireless sending set.
[0024] With the gestalt of operation of drawing 1 , while the bias control circuit 47 which performs bias control to the high-frequency power amplifying circuit 45 of a sending circuit 40 is formed, the compensation control circuit 48 which performs a gain compensatory control to the drive amplifying circuit 44 of adjustable gain is formed. And the transmitted power control signal from the transmitted power control circuit 46 is supplied to both the control circuits 47 and 48, respectively.
[0025] The high-frequency power amplifying circuit 45 and the bias control circuit 47 are constituted as shown in following drawing 2 . Moreover, the compensation control circuit 48 is constituted including a ROM table with the amount of gain fluctuation of the high-frequency power amplifying circuit 45 corresponding to the predetermined change-over level and each change-over level of transmitted power.
[0026] As shown in drawing 2 , the RF power amplification circuits 45 of the gestalt of this operation are two or more groups 45a and 45b like a proposed RF amplifying circuit.... They are two or more field-effect transistors Qa1 and Qa2 and .. which were classified into 45j, QaL;Qb1, and Qb2, .., Qbm.; .. It is constituted including;Qj1, and Qj2, .., Qjn, and all of the source of these field-effect transistors Qa1-Qjn are grounded.
[0027] The high frequency signal from an input terminal Ti is supplied through a matching circuit 2, and the capacitor calcium connected to juxtaposition at the output side and Cb....Cj common to the gate of all the each groups' 45a-45j field-effect transistors Qa1-Qjn.
[0028] Moreover, field-effect transistor Qa1-QaL;Qb1-Qbm; .... Necessary gate bias voltage is supplied to the gate of;Qj1-Qjn through Resistors Ra, Rb, .., Rj at every each group 45a and 45b, .., 45j from the bias control circuit 47 controlled by transmitted power control information.

[0029] With the gestalt of operation of drawing 2 , the firm gas of gate bias voltage Vg-on from which a field-effect transistor will be in operating state is carried out to the gate of the field-effect transistors Qa1-QaL of 1st group 45a. Moreover, field-effect transistors Qb1-Qbm of the 2nd - the j-th group 45b, ..., 45j; .. Gate bias voltage Vg-on from which a field-effect transistor will be in operating state at the gate of;Qj1-Qjn through the circuit changing switches 47b, .., 47j of the bias control circuit 47, or gate bias voltage Vg-off from which a field-effect transistor will be in non-operating state It is supplied alternatively.
[0030] And while all of the drain of each groups' 45a-45j field-effect transistors Qa1-Qjn are connected in common and a power source Vdd is supplied through a high-frequency choke coil Lch, the RF signal of each drain of field-effect transistors Qa1-Qjn is drawn by the output terminal To through a matching circuit 3.
[0031] In addition, it is not necessary to necessarily make equal several L of each groups' 45a-45j field-effect transistor, and m, ..., n. Moreover, circuit changing switches 47b, ..., 47j are made into a solid state switch, and can also be integrated like having existing proposed in the same manufacture process as field-effect transistors Qa1-Qjn.
[0032] Next, actuation of the gestalt of implementation of this invention is explained. With the gestalt of this operation, in the transmitted power control circuit 46, based on the transmitted power directions information from a base station etc., transmitted power control information is generated, this control information is supplied to the bias control circuit 47 and the compensation control circuit 48, and bias control of the high-frequency power amplifying circuit 45 and the compensatory control of the drive amplifying circuit 44 are performed.
[0033] And while power control in the RF power amplification circuit 45 is performed as a result of this bias control and a compensatory control, in the drive amplifying circuit 44, including a compensated part of the gain fluctuation accompanying the power control in the RF power amplification circuit 45, gain control is performed and the output level of the drive amplifying circuit 44 changes.
[0034] When transmission by the maximum output of the RF power amplification circuit 45 is directed using the transmitted power directions information from a base station etc., all the circuit changing switches 47b-47j of the bias control circuit 47 are switched to the n side of illustration by the transmitted power control signal generated in the transmitted power control circuit 46.
[0035] In this case, while gate bias voltage Vg-on is supplied to the gate of all the groups' 45a-45j field-effect transistors Qa1-Qjn, all the field-effect transistors Qa1-Qjn are made into operating state and the output of the RF power amplification circuit 45 serves as max, the consumed electric current also serves as max.
[0036] Moreover, when transmission with the minimum output of the RF power amplification circuit 45 is directed using transmitted power directions information, all the circuit changing switches 47b-47k of the bias control circuit 47 are switched to the f side of illustration by the transmitted power control signal generated in the transmitted power control circuit 46.
[0037] in this case, gate bias voltage Vg-off The gate of field-effect transistor Qb1-Qbm;..;Qj1-Qjn of 45j is supplied. the 2nd - j-th group 45b .... Field-effect transistors Qb1-Qbm; .... While;Qj1-Qjn is made into non-operating state While gate bias voltage Vg-on is supplied to the gate of the field-effect transistors Qa1-QaL of 1st group 45a, only field-effect transistors Qa1-QaL are made into operating state and the output of the RF power amplification circuit 45 serves as min, the consumed electric current also serves as min.
[0038] And while circuit-changing-switch 47b of the bias control circuit 47 is switched to the n side and circuit-changing-switch 47j is switched to the f side, corresponding to the value of the middle output as shown in drawing 1 when transmission with the middle output of the RF power amplification circuit 45 is directed using transmitted power directions information, a residual circuit changing switch (illustration is omitted) is suitably switched to either n side or the f side.
[0039] In this case, gate bias voltage Vg-off While the gate of the j-th field-effect transistor Qj1-Qjn of group 45j is supplied and field-effect transistors Qj1-Qjn are made into non-operating state at least Gate bias voltage Vg-on is supplied to the 1st and 2nd groups' 45a and 45b gate of field-effect transistor Qa1-QaL;Qb1-Qbm. Field-effect transistor Qa1-QaL;Qb1-

Qbm is made into operating state. A residual group's (illustration is omitted) field-effect transistor According to the value of a middle output, it considers as the condition of actuation or un-operating [either], and each the output and the consumed electric current of the RF power amplification circuit 45 serve as a middle proper value of maximum and the minimum value.
[0040] In the compensation control circuit 48, based on the above ROM tables, the amount of gain fluctuation corresponding to each change-over level of the transmitted power of the RF power amplification circuit 45 is set up, this amount of gain fluctuation is ****(ed), and control of the drive output of the drive amplifying circuit 44 is performed in the case of the above transmitted power change-overs in the RF power amplification circuit 45.
[0041] That is, when reducing transmitted power, in the high-frequency power amplifying circuit 45, as mentioned above, by the bias control circuit 47, the number of the groups of operating state decreases [a field-effect transistor], and the gain of the high-frequency power amplifying circuit 45 falls.
[0042] In this case, in the compensation control circuit 48, based on a ROM table, a part for the gain fall of the RF power amplification circuit 45 is set up, and a control signal which raises the gain of the drive amplifying circuit 44 by this gain fall is generated.
[0043] Moreover, when increasing transmitted power, in the high-frequency power amplifying circuit 45, as mentioned above, the number of the groups of operating state is increased for a field-effect transistor by the bias control circuit 47, and the gain of the high-frequency power amplifying circuit 45 goes up. In this case, in the compensation control circuit 48, based on a ROM table, a part for the gain rise of the RF power amplification circuit 45 is set up, and a control signal to which the gain of the drive amplifying circuit 44 is reduced by this gain rise is generated.
[0044] Thereby, the gain fluctuation accompanying the power control in the RF power amplification circuit 45 is compensated in the drive amplifying circuit 44.
[0045] Although the gain fluctuation accompanying transmitted power control of the RF power amplification circuit 45 was compensated, you may make it compensate the gain fluctuation accompanying transmitted power control of the RF power amplification circuit 45 with the gestalt of implementation of a gestalt] **** of operation of others [[] in the intermediate frequency amplifying circuit 42 of the preceding paragraph in the drive amplifying circuit 44 in front of the RF power amplification circuit 45 further.
[0046] Moreover, with the gestalt of above-mentioned operation, as an active element of the high-frequency power amplifying circuit 45, although the field-effect transistor was used, a bipolar transistor may be used.
[0047]
[Effect of the Invention] As explained above, according to this invention, the operating state of the active element of a RF power amplification circuit can be switched for every group, and the gain fluctuation at the time of controlling transmitted power can be compensated.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the configuration of the whole gestalt of operation of the wireless sending set by this invention.
[Drawing 2] It is drawing showing the configuration of the important section of the gestalt of operation of this invention.
[Drawing 3] It is drawing for explaining actuation of an example of the wireless sending set proposed previously.
[Drawing 4] It is drawing for explaining actuation of an example of the wireless sending set proposed previously.
[Description of Notations]
11 -- antenna, 12 -- antenna common circuit, and 20 -- a receiving circuit, 21 -- high frequency amplifying circuit, 25 -- demodulator circuit, and 26 -- a received-power detecting circuit, 31 -- baseband signaling processing circuit, 32 -- microcomputer, and 40 -- a sending circuit, 41 -- modulation circuit, 42 -- intermediate frequency amplifying circuit, and 44 -- a drive amplifying circuit, 45 -- high-frequency power amplifying circuit, a 46 -- transmitted power control circuit, and 47 -- a bias control circuit, 48 -- compensation control circuit, and Qa1 - a Qjn-- field-effect transistor

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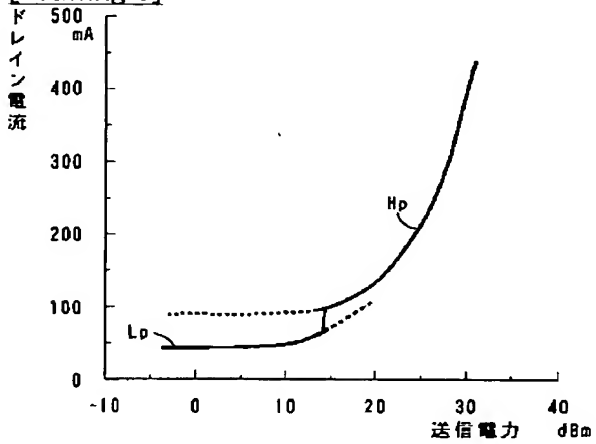
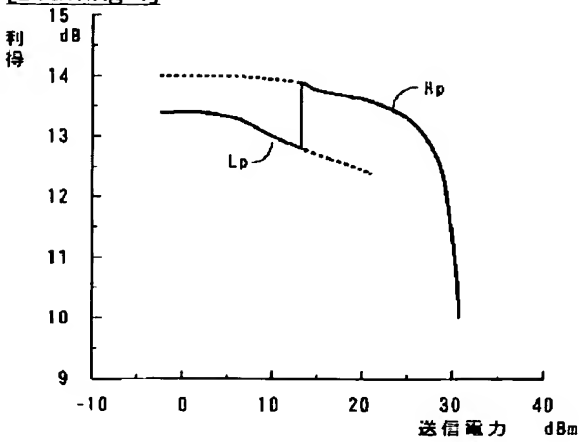
DRAWINGS

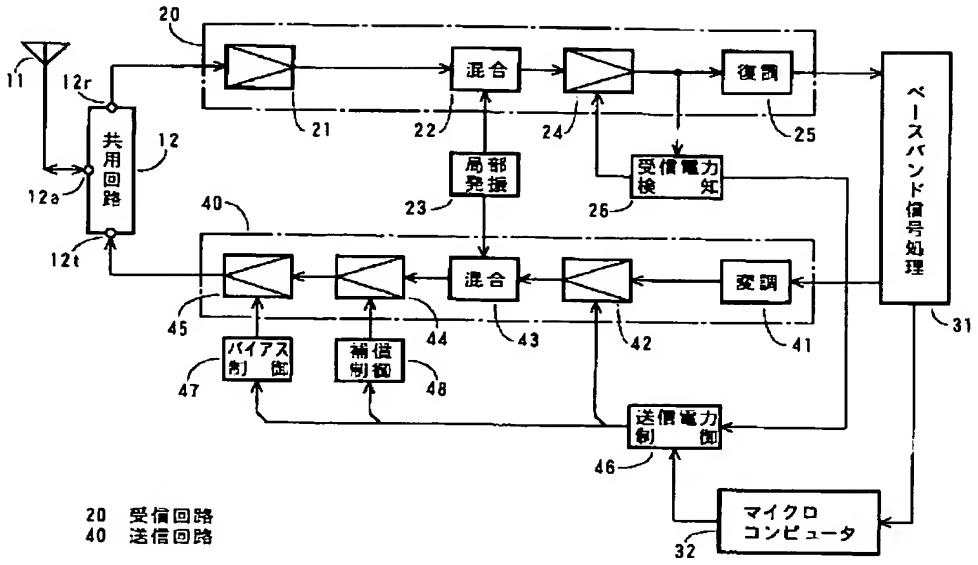
[Drawing 3]



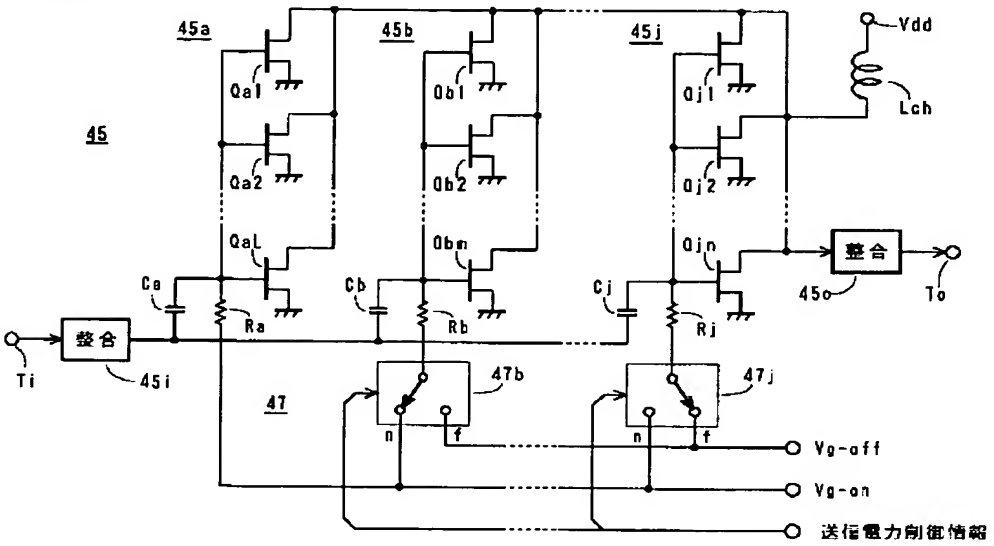
[Drawing 4]



[Drawing 1]



[Drawing 2]



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Ｈ０３Ｇ	3/20			Ｈ０３Ｇ	3/20	Ａ
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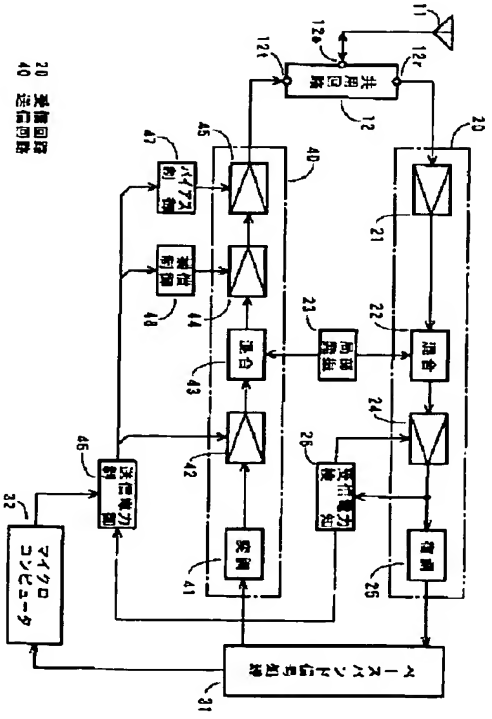
(54)【発明の名称】　無線送信装置およびその制御方法

(57)【要約】

【課題】　送信電力制御型の無線送信装置において、送信電力切換時の高周波電力増幅回路の利得変動を補償する。

【解決手段】　可変利得の駆動増幅回路４４から所定の高周波信号が供給される、高周波電力増幅回路４５の複数の電界効果トランジスタの動作状態を、送信電力制御回路４６に制御されるバイアス制御回路４７により、グループごとに切り換えて、送信電力を切り換える。この切換時の高周波電力増幅回路の利得変動を補償する補償情報の生成手段を含む、補償制御回路４８を設け、送信電力制御回路４６の制御の下に、補償制御回路により、駆動増幅回路の利得を制御する。



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【特許請求の範囲】

【請求項１】複数の群に区分した複数の能動素子を含む高周波電力増幅手段と、

この高周波電力増幅手段の所定の送信電力に対応する送信電力制御情報を発生する情報発生手段と、

この情報発生手段からの上記送信電力制御情報に基づいて、上記高周波電力増幅手段の上記能動素子の動作状態を上記群ごとに切り換える群制御手段と、

上記高周波電力増幅手段に所定の高周波信号を供給するための可変利得増幅手段とを備える無線送信装置であって、

上記能動素子の動作状態を上記群ごとに切り換える際の上記高周波電力増幅手段の利得変動を補償する補償情報の生成手段を含み、

上記補償情報と上記送信電力制御情報とに基づいて、上記可変利得増幅手段の利得を制御する補償制御手段を設けたことを特徴とする無線送信装置。

【請求項２】上記可変利得増幅手段が上記高周波電力増幅手段に直接に高周波信号を供給する駆動増幅手段である請求項１に記載の無線送信装置。

【請求項３】上記可変利得増幅手段が上記高周波電力増幅手段に間接に高周波信号を供給する中間周波増幅手段である請求項１に記載の無線送信装置。

【請求項４】可変利得増幅手段から所定の高周波信号が供給される高周波電力増幅手段の複数の能動素子を複数の群に区分し、

所定の送信電力に対応する送信電力制御情報に基づいて、上記高周波電力増幅手段の上記能動素子の動作状態を上記群ごとに切り換えるようにした無線送信装置の制御方法であって、

上記能動素子の動作状態を上記群ごとに切り換える際の上記高周波電力増幅手段の利得変動を補償する補償情報を生成し、

この補償情報と上記送信電力制御情報とに基づいて、上記可変利得増幅手段の利得を制御するようにしたことを特徴とする無線送信装置の制御方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】この発明は、例えば、携帯電話などに好適な、送信電力制御型の無線送信装置およびその制御方法に関する。

【０００２】

【従来の技術】従来、例えば、携帯電話など、多くの無線通信装置では、消費電力の節減や、他局との干渉低減などのために、送信電力制御が行なわれている。このような無線通信装置では、受信信号レベル、もしくは基地局などの相手局からの指示信号に基づいて、高周波電力増幅回路の駆動信号レベルを変化させることにより、送信電力制御が行なわれるように構成されることが多い。

【０００３】また、低送信出力時の高周波電力増幅回路

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の効率を向上させるために、この高周波電力増幅回路に電源から供給される直流電力を、送信電力制御情報に応じて制御する技術が、例えば、特開平１－３１４４３１号公報や特公平６－９３６３１号公報などに開示されている。

【０００４】これらの送信電力制御方式では、低送信出力時に、高周波電力増幅回路を構成する電界効果トランジスタのゲート電圧を変化させることにより、あるいは、ドレイン電圧を低減することにより、いずれもドレイン電流を低減して、高周波電力増幅回路の消費電力を減少させるようにしている。

【０００５】

【発明が解決しようとする課題】ところが、電界効果トランジスタのゲート電圧対ドレイン電流特性は理想的な直線特性になっていないため、前述のような送信電力制御方式では、利得の低下や歪特性の劣化に制約されて、低送信出力時にも、電界効果トランジスタのドレイン電流をあまり低減させることができず、高周波電力増幅回路の消費電力を大幅に減少させることができないという問題があった。

【０００６】このような問題を解消するため、本出願人は、平成７年４月２７日付の特許出願（整理番号Ｓ９５０２１５４２）において、低出力時において消費電力を格段に低減することができる「高周波増幅回路、送信装置及び受信装置」を既に提案している。

【０００７】既提案の高周波増幅回路では、ソース接地接続の複数の電界効果トランジスタが複数のグループに区分され、各グループごとに、電界効果トランジスタのゲートに共通に接続された、直流阻止用の複数のコンデンサを通じて、入力端子からの高周波信号が、全ての電界効果トランジスタのゲートに共通に供給される。

【０００８】また、電界効果トランジスタのゲートには、各グループごとに、抵抗器を通じて、電界効果トランジスタが動作状態もしくは非動作状態となる、所要のゲートバイアス電圧が、例えば、基地局からの送信電力指示情報に応じて、選択的に供給される。

【０００９】そして、各グループの電界効果トランジスタのドレインは、全て共通に接続され、高周波チョークコイルを通じて、電源が供給されると共に、電界効果トランジスタの各ドレインの高周波信号が出力端子に導出される。なお、各グループの電界効果トランジスタの数は必ずしも等しくする必要はない。

【００１０】上述のような構成により、既提案の高周波増幅回路では、送信出力電力が高いときは、全グループの電界効果トランジスタが動作状態とされると共に、送信信号電力が低いときには、幾つかのグループのゲートバイアス電圧を切り換えて非動作状態にする。

【００１１】これにより、既提案の高周波増幅回路では、図３に曲線Ｌｐで示すように、例えば、出力電力１５ｄＢｍ以下の低出力時には、電界効果トランジスタの

うち、ほぼ半数が動作状態とされるように、ゲートバイアス電圧が適宜に切り換えられて、全体として、ドレイン電流を約１／２に低減することができ、低送信出力時に、利得の低下、歪特性の劣化を伴わずに、高周波電力増幅回路の消費電力を大幅に減少させることができる。

【００１２】しかしながら、上述のような既提案の高周波増幅回路では、電界効果トランジスタの動作もしくは非動作の制御による、出力電力の切換え時に、例えば、図４に曲線Ｈｐ，Ｌｐで示すように、約１．３ｄＢの利得変動が生じてしまい、この利得の不連続性が、無線通信装置ないしは無線回線の安定性に影響を及ぼすという問題が生ずる。

【００１３】かかる点に鑑み、この発明の目的は、出力電力の切換え時に、高周波電力増幅回路の利得変動を補償することができる、無線送信装置およびその制御方法を提供するところにある。

【００１４】

【課題を解決するための手段】前記課題を解決するため、第１のこの発明による無線送信装置は、複数の群に区分した複数の能動素子を含む高周波電力増幅手段と、この高周波電力増幅手段の所定の送信電力に対応する送信電力制御情報を発生する情報発生手段と、この情報発生手段からの送信電力制御情報に基づいて、高周波電力増幅手段の能動素子の動作状態を群ごとに切り換える群制御手段と、高周波電力増幅手段に所定の高周波信号を供給するための可変利得増幅手段とを備える無線送信装置であって、能動素子の動作状態を群ごとに切り換える際の高周波電力増幅手段の利得変動を補償する補償情報の生成手段を含み、補償情報と送信電力制御情報とに基づいて、可変利得増幅手段の利得を制御する補償制御手段を設けたことを特徴とするものである。

【００１５】また、第２のこの発明による無線送信装置の制御方法は、可変利得増幅手段から所定の高周波信号が供給される高周波電力増幅手段の複数の能動素子を複数の群に区分し、所定の送信電力に対応する送信電力制御情報に基づいて、高周波電力増幅手段の能動素子の動作状態を群ごとに切り換えるようにした無線送信装置の制御方法であって、能動素子の動作状態を群ごとに切り換える際の高周波電力増幅手段の利得変動を補償する補償情報を生成し、この補償情報と送信電力制御情報とに基づいて、可変利得増幅手段の利得を制御するようにしたことを特徴とするものである。

【００１６】

【発明の実施の形態】以下、図１および図２を参照しながら、この発明による無線送信装置およびその制御方法の実施の形態について説明する。

【００１７】この発明の実施の形態の全体の構成を図１に示し、その要部の構成を図２に示す。

【００１８】図１において、周波数分割デュプレクス方式に対応するため、送受信用のアンテナ１１が、アンテナ共用回路１２のアンテナポート１２ａに接続される。このアンテナ共用回路１２は、送信側ポート１２ｔおよび受信側のポート１２ｒを備え、所定の特性の帯域通過フィルタ（図示は省略）が、アンテナポート１２ａと送信側ポート１２ｔとの間と、アンテナポート１２ａと受信側ポート１２ｒとの間とに、それぞれ接続される。

【００１９】アンテナ共用回路１２の受信側ポート１２ｒからの高周波信号が、受信回路２０の低雑音高周波増幅回路２１を通じて、混合回路２２に供給される。この混合回路２２には、局部発振回路２３からの局部発振信号が供給されており、低雑音増幅回路２１からの高周波信号は中間周波信号に変換され、中間周波増幅回路２４を通じて、復調回路２５に供給されると共に、受信電力検知回路２６に供給される。

【００２０】この受信電力検知回路２６の出力が中間周波増幅回路２４に負帰還されて、その利得が自動的に制御されると共に、復調回路２５の出力はベースバンド信号処理回路３１に供給されて、所定の信号処理が施され、音声信号などの受信情報が再生される。再生された受信情報には、基地局などからの送信電力指示情報が含まれており、この指示情報がマイクロコンピュータ３２に取り込まれる。

【００２１】また、ベースバンド信号処理回路３１においては、音声信号などの送信情報に所定の信号処理が施されて、ベースバンド信号処理回路３１の出力信号が、送信回路４０の変調回路４１に供給され、変調回路４１の出力が、中間周波増幅回路４２を通じて、混合回路４３に供給される。

【００２２】この混合回路４３には、局部発振回路２３からの局部発振信号が供給されて、中間周波増幅回路４２からの中間周波信号が高周波信号に変換され、駆動増幅回路４４および高周波電力増幅回路４５を通じて、アンテナ共用回路１２の送信側ポート１２ｔに供給される。

【００２３】なお、中間周波増幅回路４２は、送信電力制御回路４６からの送信電力制御信号により、その利得が制御される。この送信電力制御信号は、受信電力検知回路２６からの受信電力検知情報と、マイクロコンピュータ３２からの送信電力指示情報とに基づいて生成される。上述のような構成は、既提案の無線送信装置と同様である。

【００２４】図１の実施の形態では、送信回路４０の高周波電力増幅回路４５に対してバイアス制御を行うバイアス制御回路４７が設けられると共に、可変利得の駆動増幅回路４４に対して利得補償制御を行う補償制御回路４８が設けられる。そして、両制御回路４７，４８には、それぞれ送信電力制御回路４６からの送信電力制御信号が供給される。

【００２５】高周波電力増幅回路４５とバイアス制御回路４７とは、次の図２に示すように構成される。また、

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補償制御回路４８は、例えば、送信電力の所定の切換レベルと、各切換レベルに対応する高周波電力増幅回路４５の利得変動量とのＲＯＭテーブルを含んで構成される。

【００２６】図２に示すように、この実施の形態の高周波電力増幅回路４５は、既提案の高周波増幅回路と同様に、複数のグループ４５ａ，４５ｂ‥‥４５ｊに区分された、複数の電界効果トランジスタＱａ１，Ｑａ２，‥‥，ＱａＬ；Ｑｂ１，Ｑｂ２，‥‥，Ｑｂｍ；‥‥；Ｑｊ１，Ｑｊ２，‥‥，Ｑｊｎを含んで構成され、これらの電界効果トランジスタＱａ１～Ｑｊｎのソースが全て接地される。

【００２７】入力端子Ｔｉからの高周波信号が、整合回路２と、その出力側に並列に接続されたコンデンサＣａ，Ｃｂ‥‥Ｃｊとを通じて、各グループ４５ａ～４５ｊの全ての電界効果トランジスタＱａ１～Ｑｊｎのゲートに共通に供給される。

【００２８】また、電界効果トランジスタＱａ１～ＱａＬ；Ｑｂ１～Ｑｂｍ；‥‥；Ｑｊ１～Ｑｊｎのゲートには、送信電力制御情報により制御されるバイアス制御回路４７から、抵抗器Ｒａ，Ｒｂ，‥‥，Ｒｊを通じて、各グループ４５ａ，４５ｂ，‥‥，４５ｊごとに、所要のゲートバイアス電圧が供給される。

【００２９】図２の実施の形態では、第１のグループ４５ａの電界効果トランジスタＱａ１～ＱａＬのゲートには、電界効果トランジスタが動作状態となるゲートバイアス電圧Ｖg-onが常時供給される。また、第２～第ｊのグループ４５ｂ，‥‥，４５ｊの電界効果トランジスタＱｂ１～Ｑｂｍ；‥‥；Ｑｊ１～Ｑｊｎのゲートには、バイアス制御回路４７の切換えスイッチ４７ｂ，‥‥，４７ｊを通じて、電界効果トランジスタが動作状態となるゲートバイアス電圧Ｖg-on、または、電界効果トランジスタが非動作状態となるゲートバイアス電圧Ｖg-off が、選択的に供給される。

【００３０】そして、各グループ４５ａ～４５ｊの電界効果トランジスタＱａ１～Ｑｊｎのドレインは、全て共通に接続され、高周波チョークコイルＬchを通じて、電源Ｖddが供給されると共に、電界効果トランジスタＱａ１～Ｑｊｎの各ドレインの高周波信号が、整合回路３を通じて、出力端子Ｔｏに導出される。

【００３１】なお、各グループ４５ａ～４５ｊの電界効果トランジスタの数Ｌ，ｍ，‥‥，ｎは必ずしも等しくする必要はない。また、切換えスイッチ４７ｂ，‥‥，４７ｊは、例えば、半導体スイッチとされ、既提案のように、電界効果トランジスタＱａ１～Ｑｊｎと同じ製造プロセスで集積化することも可能である。

【００３２】次に、この発明の実施の形態の動作について説明する。この実施の形態では、送信電力制御回路４６において、例えば、基地局などからの送信電力指示情報に基づいて、送信電力制御情報が生成され、この制御情報がバイアス制御回路４７および補償制御回路４８に

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供給されて、高周波電力増幅回路４５のバイアス制御と、駆動増幅回路４４の補償制御とが行なわれる。

【００３３】そして、このバイアス制御および補償制御の結果として、高周波電力増幅回路４５における電力制御が行われると共に、駆動増幅回路４４においては、高周波電力増幅回路４５における電力制御に伴う利得変動の補償分を含んで、利得制御が行われて、駆動増幅回路４４の出力レベルが変化する。

【００３４】基地局などからの送信電力指示情報により、高周波電力増幅回路４５の最大出力での送信が指示された場合、送信電力制御回路４６において生成された送信電力制御信号により、バイアス制御回路４７の全ての切換えスイッチ４７ｂ～４７ｊが、図示のｎ側に切り換えられる。

【００３５】この場合、ゲートバイアス電圧Ｖg-onが、全てのグループ４５ａ～４５ｊの電界効果トランジスタＱａ１～Ｑｊｎのゲートに供給されて、全ての電界効果トランジスタＱａ１～Ｑｊｎが動作状態とされ、高周波電力増幅回路４５の出力が最大となると共に、消費電流も最大となる。

【００３６】また、送信電力指示情報により、高周波電力増幅回路４５の最小出力での送信が指示された場合は、送信電力制御回路４６において生成された送信電力制御信号により、バイアス制御回路４７の全ての切換えスイッチ４７ｂ～４７ｋが、図示のｆ側に切り換えられる。

【００３７】この場合は、ゲートバイアス電圧Ｖg-offが、第２～第ｊのグループ４５ｂ‥‥４５ｊの電界効果トランジスタＱｂ１～Ｑｂｍ；‥‥；Ｑｊ１～Ｑｊｎのゲートに供給されて、電界効果トランジスタＱｂ１～Ｑｂｍ；‥‥；Ｑｊ１～Ｑｊｎが非動作状態とされると共に、ゲートバイアス電圧Ｖg-onが、第１グループ４５ａの電界効果トランジスタＱａ１～ＱａＬのゲートに供給されて、電界効果トランジスタＱａ１～ＱａＬのみが動作状態とされ、高周波電力増幅回路４５の出力が最小となると共に、消費電流も最小となる。

【００３８】そして、送信電力指示情報により、高周波電力増幅回路４５の中間出力での送信が指示された場合には、その中間出力の値に応じて、例えば、図１に示すように、バイアス制御回路４７の切換えスイッチ４７ｂがｎ側に切り換えられ、切換えスイッチ４７ｊがｆ側に切り換えられると共に、残余の切換えスイッチ（図示は省略）は、ｎ側またはｆ側のいずれかに適宜に切り換えられる。

【００３９】この場合には、ゲートバイアス電圧Ｖg-offが、少なくとも、第ｊのグループ４５ｊの電界効果トランジスタＱｊ１～Ｑｊｎのゲートに供給されて、電界効果トランジスタＱｊ１～Ｑｊｎが非動作状態とされると共に、ゲートバイアス電圧Ｖg-onが、第１および第２のグループ４５ａ，４５ｂの電界効果トランジスタＱａ１～ＱａＬ；

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Qb1～Qbmのゲートに供給されて、電界効果トランジスタQa1～QaL；Qb1～Qbmが動作状態とされ、残余のグループ（図示は省略）の電界効果トランジスタは、中間出力の値に応じて、動作または非動作のいずれかの状態とされ、高周波電力増幅回路４５の出力および消費電流は、いずれも最大値と最小値との中間の適宜の値となる。

【００４０】高周波電力増幅回路４５における、上述のような送信電力切換の際には、補償制御回路４８において、前述のようなＲＯＭテーブルに基づいて、高周波電力増幅回路４５の送信電力の各切換レベルに対応する利得変動量が設定され、この利得変動量を加除して、駆動増幅回路４４の駆動出力の制御が行われる。

【００４１】即ち、送信電力を低減する場合、高周波電力増幅回路４５においては、上述のように、バイアス制御回路４７により、電界効果トランジスタが動作状態のグループの数が減少されて、高周波電力増幅回路４５の利得が低下する。

【００４２】この場合、補償制御回路４８においては、ＲＯＭテーブルに基づいて、高周波電力増幅回路４５の利得低下分が設定され、この利得低下分だけ、駆動増幅回路４４の利得を上昇させるような制御信号を発生する。

【００４３】また、送信電力を増加する場合は、高周波電力増幅回路４５においては、上述のように、バイアス制御回路４７により、電界効果トランジスタが動作状態のグループの数が増やされて、高周波電力増幅回路４５の利得が上昇する。この場合は、補償制御回路４８においては、ＲＯＭテーブルに基づいて、高周波電力増幅回路４５の利得上昇分が設定され、この利得上昇分だけ、駆動増幅回路４４の利得を低下させるような制御信号を発生する。

【００４４】これにより、高周波電力増幅回路４５における電力制御に伴う利得変動が、駆動増幅回路４４において補償される。

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【００４５】〔他の実施の形態〕上述の実施の形態では、高周波電力増幅回路４５の直前の駆動増幅回路４４において、高周波電力増幅回路４５の送信電力制御に伴う利得変動を補償するようにしたが、更に前段の、中間周波増幅回路４２において、高周波電力増幅回路４５の送信電力制御に伴う利得変動を補償するようにしてもよい。

【００４６】また、上述の実施の形態では、高周波電力増幅回路４５の能動素子として、電界効果トランジスタを用いたが、バイポーラトランジスタを用いてもよい。

【００４７】

【発明の効果】以上説明したように、この発明によれば、高周波電力増幅回路の能動素子の動作状態を群ごとに切り換えて、送信電力を制御する際の利得変動を補償することができる。

【図面の簡単な説明】

【図１】この発明による無線送信装置の実施の形態の全体の構成を示すブロック図である。

【図２】この発明の実施の形態の要部の構成を示す図である。

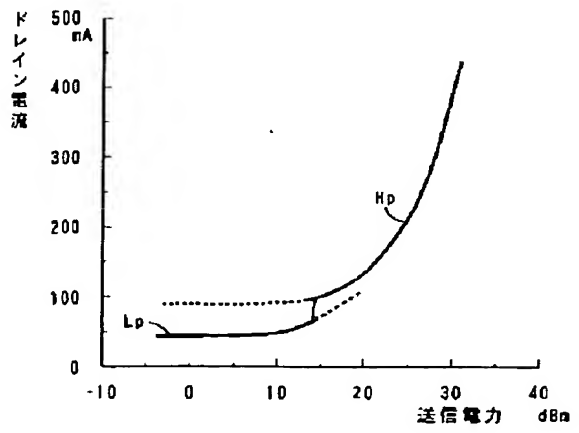
【図３】先に提案した無線送信装置の一例の動作を説明するための図である。

【図４】先に提案した無線送信装置の一例の動作を説明するための図である。

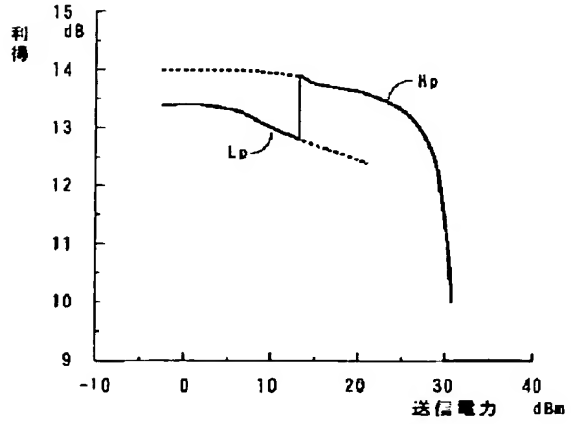
【符号の説明】

１１…アンテナ、１２…アンテナ共用回路、２０…受信回路、２１…高周波増幅回路、２５…復調回路、２６…受信電力検知回路、３１…ベースバンド信号処理回路、３２…マイクロコンピュータ、４０…送信回路、４１…変調回路、４２…中間周波増幅回路、４４…駆動増幅回路、４５…高周波電力増幅回路、４６…送信電力制御回路、４７…バイアス制御回路、４８…補償制御回路、Qa1～Qjn…電界効果トランジスタ

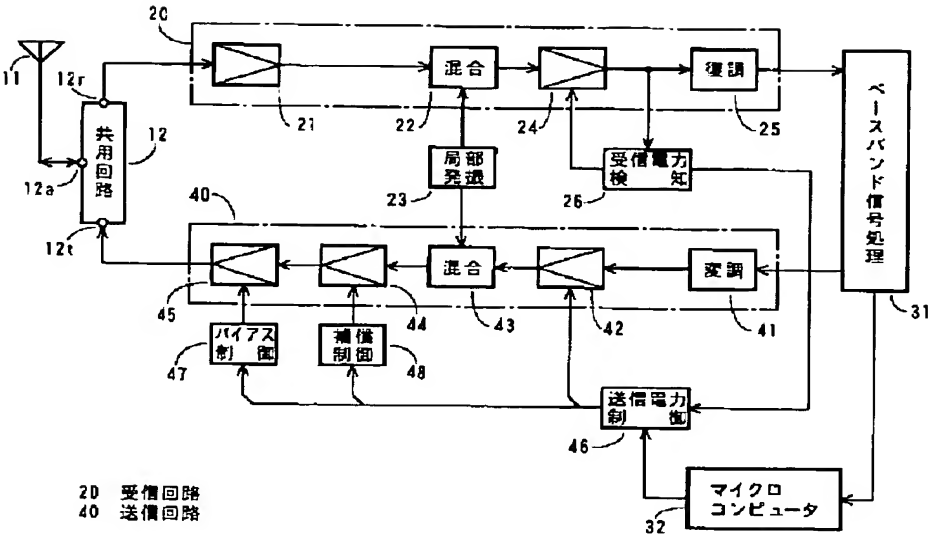
【図３】



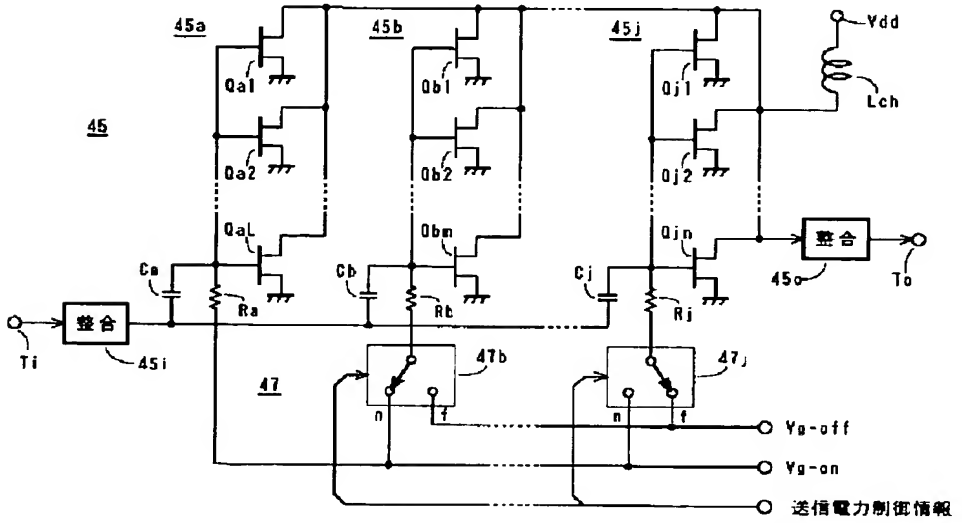
【図４】



【図１】



【図２】



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